Advancing Solar Irradiance Measurements for Climate-related Studies: Accurate Constraint on Direct Aerosol Radiative Effect (DARE)

SI-CHEE TSAY AND Q. JACK JI

NASA Goddard Space Flight Center, Greenbelt, MD, USA

Earth's climate is driven primarily by solar radiation. As summarized in various IPCC reports, the global average of radiative forcing for different agents and mechanisms, such as aerosols or CO_2 doubling, is in the range of a few W m^{-2}. However, when solar irradiance is measured by broadband radiometers, such as the fleet of Eppley Precision Solar Pyranometers (PSP) and equivalent instrumentation employed worldwide, the measurement uncertainty is larger than 2% (e.g., *WMO* specification of pyranometer, 2008). Thus, out of the ~184 W m^{-2} (~263 W m^{-2} if cloud-free) surface solar insolation (Trenberth *et al.* 2009), the measurement uncertainty is greater than ±3.6 W m^{-2}, overwhelming the climate change signals. To discern these signals, less than a 1% measurement uncertainty is required and is currently achievable only by means of a newly developed methodology employing a modified PSP-like pyranometer and an updated calibration equation to account for its thermal effects (Ji and Tsay, 2010).

In this talk, we will show that some auxiliary measurements, such as those from a collocated pyrgeometer or air temperature sensors, can help correct historical datasets. Additionally, we will also demonstrate that a pyrheliometer is not free of the thermal effect; therefore, comparing to a high cost yet still not thermal-effect-free "direct + diffuse" approach in measuring surface solar irradiance, our new method is more economical, and more likely to be suitable for correcting a wide variety of historical datasets. Modeling simulations will be presented that a corrected solar irradiance measurement has a significant impact on aerosol forcing, and thus plays an important role in climate studies.

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